Location Entry Codes

As part of CIE's continual commitment to maintaining best practice in assessment, CIE uses different variants of some question papers for our most popular assessments with large and widespread candidature. The question papers are closely related and the relationships between them have been thoroughly established using our assessment expertise. All versions of the paper give assessment of equal standard.

The content assessed by the examination papers and the type of questions is unchanged.

This change means that for this component there are now two variant Question Papers, Mark Schemes and Principal Examiner's Reports where previously there was only one. For any individual country, it is intended that only one variant is used. This document contains both variants which will give all Centres access to even more past examination material than is usually the case.

The diagram shows the relationship between the Question Papers, Mark Schemes and Principal Examiners' Reports that are available.

Question Paper	**Mark Scheme**	**Principal Examiner's Report**
Introduction	Introduction	Introduction
First variant Question Paper	First variant Mark Scheme	First variant Principal Examiner's Report
Second variant Question Paper	Second variant Mark Scheme	Second variant Principal Examiner's Report

Who can I contact for further information on these changes?
Please direct any questions about this to CIE's Customer Services team at:
international@cie.org.uk

The titles for the variant items should correspond with the table above, so that at the top of the first page of the relevant part of the document and on the header, it has the words:

- First variant Question Paper / Mark Scheme / Principal Examiner's Report

or

- Second variant Question Paper / Mark Scheme / Principal Examiner's Report

as appropriate.

First Variant Question Paper

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

7190250824

CHEMISTRY **0620/31**

Paper 3 (Extended) **May/June 2008**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES

Answer **all** questions.
A copy of the Periodic Table is printed on page 12.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part questions.

For Examiner's Use	
1	
2	
3	
4	
5	
6	
7	
8	
Total	

This document consists of **11** printed pages and **1** blank page.

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UNIVERSITY of CAMBRIDGE International Examinations

[Turn over

For Examiner's Use

1 For each of the following select an element from Period 4, potassium to krypton, that matches the description.

(a) It is a brown liquid at room temperature. .....

(b) It forms a compound with hydrogen having the formula XH_4. .....

(c) A metal that reacts violently with cold water. .....

(d) It has a complete outer energy level. .....

(e) It has oxidation states of 2 and 3 only. .....

(f) It can form an ion of the type X^-. .....

(g) One of its oxides is the catalyst in the Contact Process. .....

[Total: 7]

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For Examiner's Use

2 **(a)** Complete the table which gives the names, symbols, relative masses and relative charges of the three subatomic particles.

name	symbol	relative mass	relative charge
electron	e^-		
proton		1	
	n		0

[3]

(b) Use the information in the table to explain the following.

(i) Atoms contain charged particles but they are electrically neutral because they have no overall charge.

.....

..... [2]

(ii) Atoms can form positive ions.

.....

..... [2]

(iii) Atoms of the same element can have different masses.

.....

..... [2]

(iv) Scientists are certain that there are no undiscovered elements missing from the Periodic Table from hydrogen to lawrencium.

..... [1]

[Total: 10]

For Examiner's Use

3 Copper is purified by electrolysis.

(a) Complete the following.

The positive electrode (anode) is made from .....

The negative electrode (cathode) is made from .....

The electrolyte is aqueous ..... [3]

(b) Write an ionic equation for the reaction at the positive electrode (anode).

..... [2]

(c) **(i)** Give **two** reasons why copper is used,

in electric wiring, ...

..... [2]

in cooking utensils. .....

..... [2]

(ii) Give another use of copper.

..... [1]

[Total: 10]

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For Examiner's Use

4 Sulphuric acid is a typical strong acid.

(a) Change the equations given into a different format.

(i) $Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$
Change into a word equation.

..... [1]

(ii) lithium oxide + sulphuric acid $\longrightarrow$ lithium sulphate + water
Change into a symbol equation.

..... [2]

(iii) $CuO + 2H^+ \longrightarrow Cu^{2+} + H_2O$
Change the ionic equation into a symbol equation.

..... [2]

(iv) $Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + CO_2 + H_2O$
Change into a word equation.

..... [1]

(b) When sulphuric acid dissolves in water, the following reaction occurs.
$H_2SO_4 + H_2O \longrightarrow HSO_4^- + H_3O^+$
Explain why water is behaving as a base in this reaction.

..... [2]

(c) Sulphuric acid is a strong acid, ethanoic acid is a weak acid.
Explain the difference between a strong acid and a weak acid.

.....

..... [2]

[Total: 10]

For Examiner's Use

5 Carbonyl chloride, $COCl_2$, is a colourless gas. It is made by the following reaction.

$$CO(g) + Cl_2(g) \underset{\text{heat}}{\overset{\text{cool}}{\rightleftharpoons}} COCl_2(g)$$

(a) When the pressure on the equilibrium mixture is decreased, the position of equilibrium moves to left.

(i) How does the concentration of each of the three chemicals change?

.....

..... [2]

(ii) Explain why the position of equilibrium moves to left.

.....

..... [2]

(b) Using the information given with the equation, is the forward reaction exothermic or endothermic? Give a reason for your choice.

.....

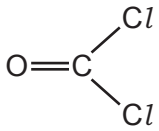
..... [2]

(c) Carbonyl chloride reacts with water to form two acidic compounds.
Suggest which acidic compounds are formed.

1. .....

2. ..... [2]

(d) The structural formula of carbonyl chloride is given below.



Draw a diagram that shows the arrangement of the valency electrons in one molecule of this covalent compound.
Use x for an electron from a chlorine atom.
Use o for an electron from a carbon atom.
Use ● for an electron from an oxygen atom.

[4]
[Total: 12]

For Examiner's Use

6 Three of the factors that can influence the rate of a chemical reaction are:

- physical state of the reactants
- light
- the presence of a catalyst

(a) The first recorded dust explosion was in a flour mill in Italy in 1785. Flour contains carbohydrates. Explosions are very fast exothermic reactions.

(i) Use the collision theory to explain why the reaction between the particles of flour and the oxygen in the air is very fast.

.....

..... [2]

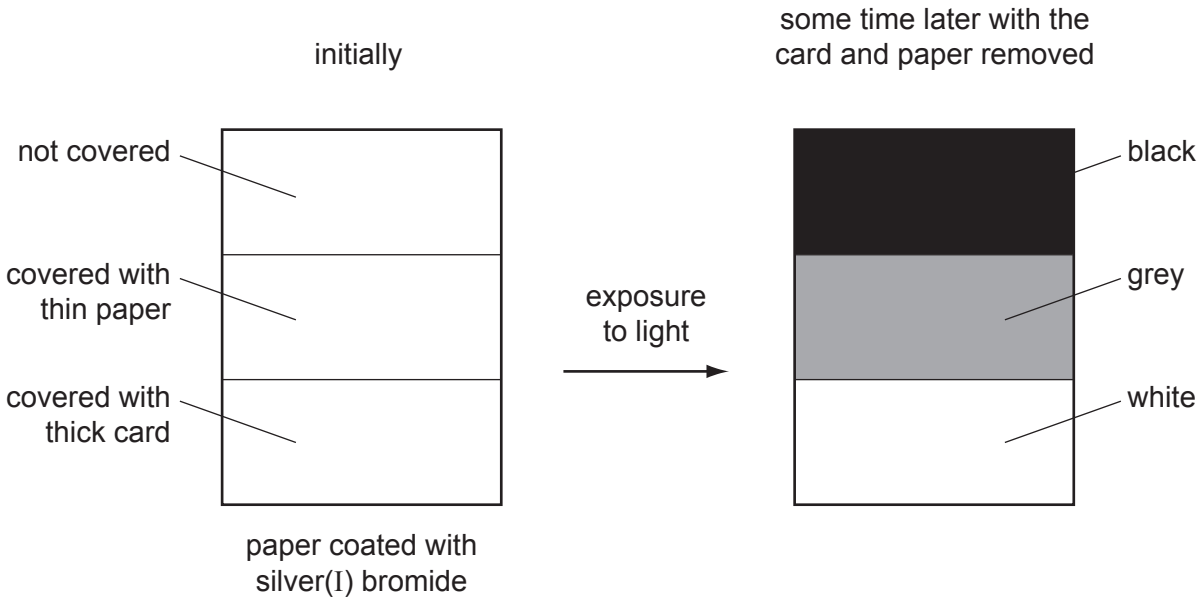
(ii) Write a word equation for this exothermic reaction.

..... [1]

The decomposition of silver(I) bromide is the basis of film photography. The equation for this decomposition is:

$$\underset{\text{white}}{2AgBr} \longrightarrow \underset{\text{black}}{2Ag} + Br_2$$

This reaction is photochemical.
A piece of white paper was coated with silver(I) bromide and the following experiment was carried out.



(b) Explain the results.

.....

.....

..... [3]

For Examiner's Use

(c) The fermentation of glucose is catalysed by enzymes from yeast. Yeast is added to aqueous glucose, the solution starts to bubble and becomes cloudy as more yeast cells are formed.

$$C_6H_{12}O_6(aq) \longrightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

The reaction is exothermic.

Eventually the fermentation stops when the concentration of ethanol is about 12%.

(i) What is an enzyme?

..... [1]

(ii) Pasteur said that fermentation was respiration in the absence of air. Suggest a definition of *respiration*.

.....

..... [2]

(iii) On a large scale, the reaction mixture is cooled. Suggest a reason why this is necessary.

..... [1]

(iv) Why does the fermentation stop? Suggest **two** reasons.

.....

..... [2]

(v) When the fermentation stops, there is a mixture of dilute aqueous ethanol and yeast. Suggest a technique which could be used to remove the cloudiness due to the yeast.

..... [1]

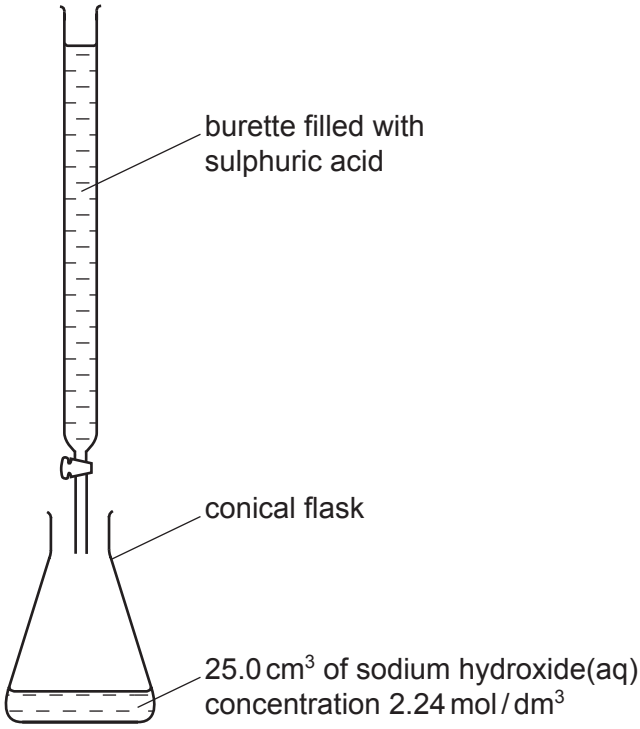
Name a technique which will separate the ethanol from the ethanol / water mixture.

..... [1]

[Total: 14]

For Examiner's Use

7 Crystals of sodium sulphate-10-water, $Na_2SO_4.10H_2O$, are prepared by titration.



(a) 25.0 cm^3 of aqueous sodium hydroxide is pipetted into a conical flask.
A few drops of an indicator are added. Using a burette, dilute sulphuric acid is slowly added until the indicator just changes colour. The volume of acid needed to neutralise the alkali is noted.

Suggest how you would continue the experiment to obtain pure, dry crystals of sodium sulphate-10-water.

.....

.....

.....

..... [4]

(b) Using 25.0 cm^3 of aqueous sodium hydroxide, 2.24 mol / dm^3, 3.86 g of crystals were obtained. Calculate the percentage yield.

$$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$$

$$Na_2SO_4 + 10H_2O \longrightarrow Na_2SO_4.10H_2O$$

Number of moles of NaOH used = ...

Maximum number of moles of $Na_2SO_4.10H_2O$ that could be formed = ...

Mass of one mole of $Na_2SO_4.10H_2O$ = 322 g

Maximum yield of sodium sulphate-10-water = ... g

Percentage yield = ... % [4]

[Total: 8]

For Examiner's Use

8 Large areas of the Amazon rain forest are cleared each year to grow soya beans. The trees are cut down and burnt.

(a) Why do these activities increase the percentage of carbon dioxide in the atmosphere?

.....

..... [2]

(b) Soya beans contain all three main food groups. Two of which are protein and carbohydrate.

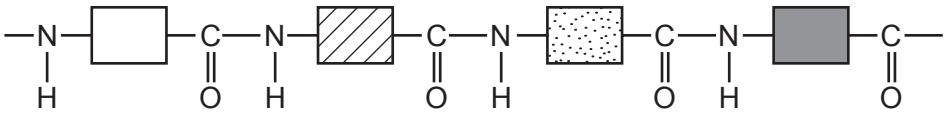
(i) What is the third group?

..... [1]

(ii) Draw the structural formula of a complex carbohydrate such as starch.

[3]

(iii) Compare the structure of a protein with that of a synthetic polyamide. The structure of a typical protein is given below.



How are they similar?

.....

How are they different?

.....

..... [3]

[Total: 9]

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DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulphur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key

a
X
b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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Second Variant Question Paper

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER						CANDIDATE NUMBER				

8672182532

CHEMISTRY **0620/32**

Paper 3 (Extended) **May/June 2008**

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES

Answer **all** questions.
A copy of the Periodic Table is printed on page 12.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part questions.

For Examiner's Use	
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UNIVERSITY of CAMBRIDGE International Examinations

For Examiner's Use

1 For each of the following select an element from Period 4, potassium to krypton, that matches the description.

(a) It is a brown liquid at room temperature. .....

(b) It forms a covalent compound with hydrogen having the formula H_2X. .....

(c) A metal that reacts violently with cold water. .....

(d) It has a complete outer energy level. .....

(e) It has oxidation states of 2 and 3 only. .....

(f) It can form an ion of the type X^+. .....

(g) This metal is the catalyst in the Haber Process. .....

[Total: 7]

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For Examiner's Use

2 **(a)** Complete the table which gives the names, symbols, relative masses and relative charges of the three subatomic particles.

name	symbol	relative mass	relative charge
electron	e^-		
proton		1	
neutron	n		

[3]

(b) Use the information in the table to explain the following.

(i) Atoms contain charged particles but they are electrically neutral - they have no overall charge.

.....

..... [2]

(ii) Atoms can form negative ions.

.....

..... [2]

(iii) Different atoms of the element chlorine are $^{35}_{17}Cl$ and $^{37}_{17}Cl$.

How are they different? .....

How are they the same? ..... [2]

(iv) Scientists are certain that there are no undiscovered elements missing from the Periodic Table from hydrogen to lawrencium.

..... [1]

[Total: 10]

For Examiner's Use

3 Copper is purified by electrolysis.

(a) Complete the following.

The positive electrode (anode) is made from .....

The negative electrode (cathode) is made from .....

The electrolyte is aqueous ..... [3]

(b) Write an ionic equation for the reaction at the positive electrode (anode).

..... [2]

(c) **(i)** Give **two** reasons why copper is used,

in electric wiring, ...

..... [2]

in cooking utensils. .....

..... [2]

(ii) Give another use of copper.

..... [1]

[Total: 10]

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For Examiner's Use

4 Sulphuric acid is a typical strong acid.

(a) Change the equation given into a different format.

(i) $Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$
Change into a word equation.

..... [1]

(ii) lithium oxide + sulphuric acid $\longrightarrow$ lithium sulphate + water
Change into a symbol equation.

..... [2]

(iii) $CuCO_3 + 2H^+ \longrightarrow Cu^{2+} + H_2O + CO_2$
Change the ionic equation into a symbol equation.

..... [2]

(iv) $Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + CO_2 + H_2O$
Change into a word equation.

..... [1]

(b) When sulphuric acid dissolves in water, the following reaction occurs.
$H_2SO_4 + H_2O \longrightarrow HSO_4^- + H_3O^+$
Explain why water is behaving as a base.

..... [2]

(c) Sulphuric acid is a strong acid, ethanoic acid is a weak acid. One way of distinguishing between them is to measure their pH. The weaker acid will have the higher pH. Describe another way by which they could be distinguished.

.....

..... [2]

[Total: 10]

For Examiner's Use

5 Carbonyl chloride, $COCl_2$, is a colourless gas. It is made by the following reaction.

$$CO(g) + Cl_2(g) \underset{\text{heat}}{\overset{\text{cool}}{\rightleftharpoons}} COCl_2(g)$$

(a) When the pressure on the equilibrium mixture is increased, the position of equilibrium moves to right.

(i) How does the concentration of each of the three chemicals change?

.....

..... [2]

(ii) Explain why the position of equilibrium moves to right.

.....

..... [2]

(b) Using the information given with the equation, is the forward reaction exothermic or endothermic? Give a reason for your choice.

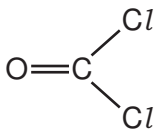
.....

..... [2]

(c) Carbonyl chloride reacts with water to form two acidic compounds.
Name them.

..... [2]

(d) The structural formula of carbonyl chloride is given below.



Draw a diagram that shows the arrangement of the valency electrons in one molecule of this covalent compound.
Use x for an electron from a chlorine atom.
Use o for an electron from a carbon atom.
Use ● for an electron from an oxygen atom.

[4]
[Total: 12]

For Examiner's Use

6 Three of the factors that can influence the rate of a chemical reaction are:

- physical state of the reactants
- light
- the presence of a catalyst

(a) The first recorded dust explosion was in a flour mill in Italy in 1785. Flour contains carbohydrates. Explosions are very fast exothermic reactions.

(i) Use the collision theory to explain why the reaction between the particles of flour and the oxygen in the air is very fast.

.....

..... [2]

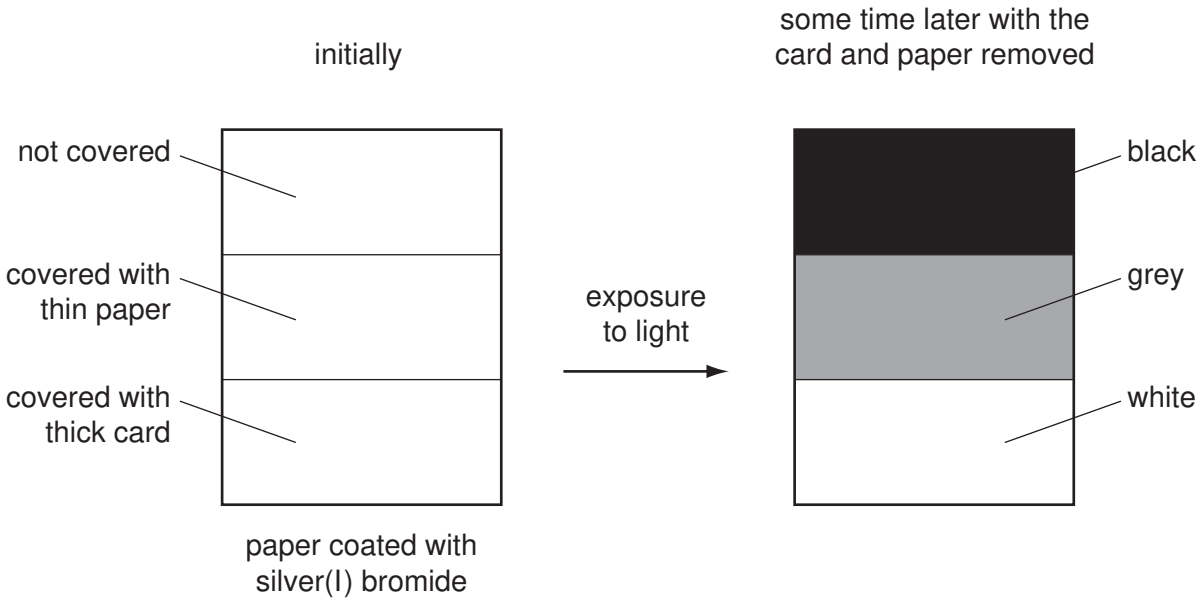
(ii) Write a word equation for this exothermic reaction.

..... [1]

The decomposition of silver(I) bromide is the basis of film photography. The equation for this decomposition is:

$$\underset{\text{white}}{2AgBr} \longrightarrow \underset{\text{black}}{2Ag} + Br_2$$

(b) This reaction is photochemical.
A piece of white paper was coated with silver(I) bromide and the following experiment was carried out.



Explain the results.

.....

.....

..... [3]

For Examiner's Use

(c) The fermentation of glucose is catalysed by enzymes from yeast. Yeast is added to aqueous glucose, the solution starts to bubble and becomes cloudy as more yeast cells are formed.

$$C_6H_{12}O_6(aq) \longrightarrow 2C_2H_5OH(aq) + 2CO_2(g)$$

The reaction is exothermic.

Eventually the fermentation stops when the concentration of ethanol is about 12%.

(i) What is an enzyme?

..... [1]

(ii) Pasteur said that fermentation was respiration in the absence of air. Define *respiration*.

.....

..... [2]

(iii) On a large scale, the reaction mixture is cooled. Suggest a reason why this is necessary.

..... [1]

(iv) Why does the fermentation stop? Suggest **two** reasons.

.....

..... [2]

(v) When the fermentation stops, there is a mixture of dilute aqueous ethanol and yeast. Suggest a technique which could be used to remove the cloudiness due to the yeast.

..... [1]

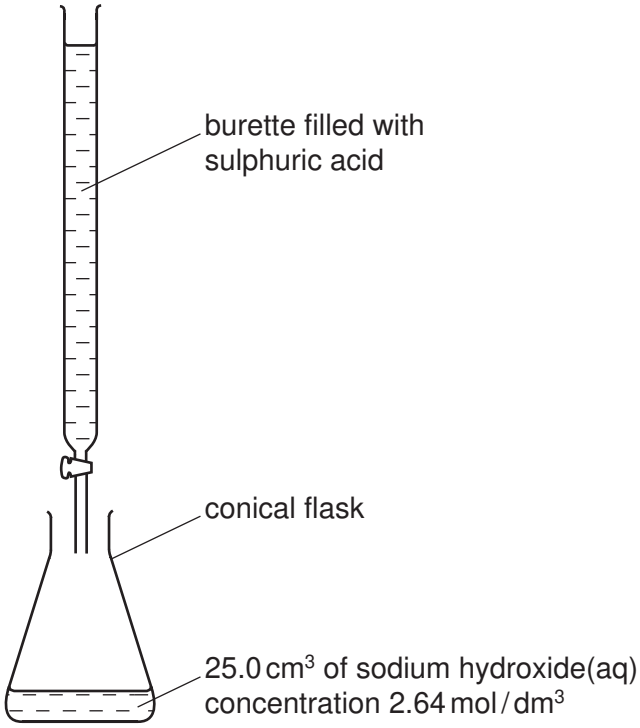
Name another technique which will separate the ethanol from the ethanol / water mixture.

..... [1]

[Total: 14]

For Examiner's Use

7 Crystals of sodium sulphate-10-water, $Na_2SO_4.10H_2O$, are prepared by titration.



(a) 25.0 cm^3 of aqueous sodium hydroxide is pipetted into a conical flask.
A few drops of an indicator are added. Using a burette, dilute sulphuric acid is slowly added until the indicator just changes colour. The volume of acid needed to neutralise the alkali is noted.

Suggest how you would continue the experiment to obtain pure, dry crystals of sodium sulphate-10-water.

.....

.....

.....

..... [4]

(b) Using 25.0 cm^3 of aqueous sodium hydroxide, 2.64 mol / dm^3, 3.95 g of crystals were obtained. Calculate the percentage yield.

$$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$$

$$Na_2SO_4 + 10H_2O \longrightarrow Na_2SO_4.10H_2O$$

Number of moles of NaOH used = ...

Maximum number of moles of $Na_2SO_4.10H_2O$ that could be formed = ...

Mass of one mole of $Na_2SO_4.10H_2O$ = 322 g

Maximum yield of sodium sulphate-10-water = ... g

Percentage yield = ... % [4]

[Total: 8]

For Examiner's Use

8 Large areas of the Amazon rain forest are cleared each year to grow soya beans. The trees are cut down and burnt.

(a) Why do these activities increase the percentage of carbon dioxide in the atmosphere?

.....

..... [2]

(b) Soya beans contain all three main food groups. Two of which are protein and carbohydrate.

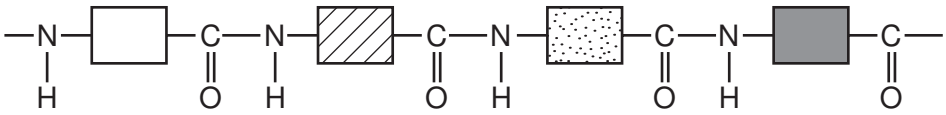
(i) What is the third group?

..... [1]

(ii) Draw the structural formula of a complex carbohydrate such as starch.

[3]

(iii) Compare the structure of a protein with that of a synthetic polyamide. The structure of a typical protein is given below.



How are they similar?

.....

How are they different?

.....

..... [3]

[Total: 9]

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DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
							1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key

a X b	a = relative atomic mass X = atomic symbol b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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